Master 2

INTERNSHIP PROPOSAL

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Thesis possibility after internship: YES

Lagrangian particle dynamics at oceanic submesoscales and future satellite data

Ocean flows at scales larger than few tens of km are quasi-horizontal due to the pronounced stratification of seawater and Earth's rotation and are characterized by quasi-2D turbulence. At scales around 300 km (the mesoscale range), coherent structures (almost circular vortices) contain most of the kinetic energy and are key for ocean dynamics at climatic scales. At scales around 10 km (the submesoscale range) the flow is host to smaller eddies and filaments associated with strong gradients of physical properties (e.g. temperature) and intense vertical transport, which play an important role in both physical and biogeochemical budgets. Mesoscale and submesoscale flows also shape the physical and chemical environment in which life develops in the ocean (Fig. 1). Direct observation of submesoscale surface velocity fields at global scale is still not possible but it should be achieved in the near future by the satellite SWOT (NASA-CNES, launch in 2022).

To compute large-scale horizontal transport, surface energy exchanges or global estimates of other quantities, it is crucial to assess how well the horizontal velocities provided by the satellite compare to actual surface currents and down to what length scale. For this purpose, Lagrangian approaches provide an ideal framework, as, differently from standard Eulerian ones, they integrate in time the signal. Thanks to this property, they may allow a clear separation between fast (ageostrophic) processes, that could contaminate the satellite-derived velocity, and slower (geostrophic) ones.

In this internship, funded by CNES, we will explore Lagrangian transport in a model of surface ocean turbulence including ageostrophic dynamics by means of numerical simulations. Using the SWOT simulator software with the numerically computed flows, it will be also possible to examine the effect of the data processing that will be applied to the real observations. The analysis will rely on the comparison of different statistical indicators of Lagrangian dispersion in the original and processed flows. The aim is to determine the effect of unresolved motions, and of the data processing procedure, on dispersion features. In particular, this study should allow the identification of a threshold length scale above which the approximate velocity field is accurate enough, at least in a statistical sense, as well as an estimate of the kinetic energy of the missing small scales.

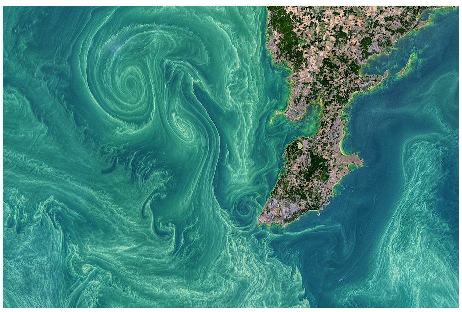

Figure 1: Signature of submesoscale turbulence on chlorophyll, a proxy for phytoplankton, as seen in a satellite image of the ocean color in the Baltic Sea [oceancolor.gsfc.nasa.gov/gallery/].

Keywords: turbulence, oceanography, numerical modeling